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NOISE MEASUREMENT OF AUXILIARY MINE FANS AT STANLEIGH URANIUM MINE IN ELLIOT LAKE

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ELLIOT LAKE LABORATORY

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NOISE MEASUREMENT OF AUXILIARY MINE FANS AT STANLEIGH URANIUM MINE IN ELLIOT LAKE

by

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ABSTRACT

Noise measurements were taken from thirty-nine auxiliary mining fans at Stanleigh uranium mine,which is being reopened. The average noise level of all fans is 110.41 dBA.

A comparison of various fans was made. The best performance was achieved with a 75 hp fan using two silencers and an attenuating casing cover.

A study of the fans reveals that the fan maintenance is very good at the mine as the peak L_{eq} difference is fairly constant for all types of fans (11.76 dB average value).

The relationship between fan noise and NEI was studied. The question of peaks was discussed. This discussion resulted in the suggestion of a new field of study - investigation of peak values and their effect on NEI.

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INTRODUCTION

Stanleigh uranium mine in Elliot Lake has recently been reopened and is being prepared for renewal of ore production on a large scale. Stanleigh mine has five levels (Appendix A-1 to A-5).

Noise measurements were taken from 40 of the underground auxiliary mine fans manufactured by Davidson (29 fans), Woods (6 fans), Engart (4 fans) and Joy (1 fan). Five fans were either inaccessible or idle. Two fans were measured after a change in fan installation.

The purpose behind the measurements was to:

a) make a direct comparison of various fans

b) see if maintenance was required on any fans

c) see the relationship between fan noise and noise exposure index (NEI).

All data available on the fans is in English units because this system is still used by Stanleigh mine and the fan companies.

INSTRUMENT

All measurements were taken using the Brüel and Kjaer Integrating Sound Level Meter Type 2225 using a half-inch condenser microphone. The 2225 was designed to assess hearing damage risk and has a choice of four functions:

a) 60s L_{eq}, for a short term average value

b) FAST, for normal sound level measurement

c) SLOW, when the display fluctuates too rapidly to use FAST

d) PEAK, which holds the maximum peak value occurring before the instrument is reset.

The PEAK function uses a rise time of 30 μs, which is very important for hearing damage risk assessment. The 2225 also has D.C. output capability

used for permanent documentation using a Level Recorder (Fig. 1)(1).

The Noise Survey Form was designed and produced in book form to be used with the aluminum case (Fig. 1). The form has one column for the important value of L_{eq} and three columns to use for SLOW, FAST and PEAK values should these measurements be required.

The Sound Level Meter (SLM) was carried in an aluminum case designed to allow the SLM to be used and read while reducing the possibility of damage to the instrument. The case also has an antenna with a clip at its end (Fig. 1). The microphone is placed in this clip and the antenna extended to allow remote placement of the microphone. This feature is used for:

a) practical measurements of noise sources (fans, machines, etc.).

b) short measurements of Noise Exposure Index (NEI) of miners or workers in general. This is done by placing the microphone next to the miner's ear. This allows the technician to remain safely out of the immediate work area and lets the miner work undisturbed.

c) measuring the efficiency of ear muffs. This is done by taking a noise measurement with the microphone placed under the earmuff next to the ear and then taking a measurement near the ear outside the earmuff. The difference between these two values is the attenuation of the earmuffs, assuming the noise level remains constant. The case and SLM can be used in conjunction with a Level Recorder and worn by an operator to measure the NEI of an LHD operator, for example, while the technician waits in a safer area.

The case also has a wide strap allowing the SLM to be carried over a shoulder for easy 'hands-off' transportation of the SLM and case. The case was built at the Elliot Lake Laboratory.

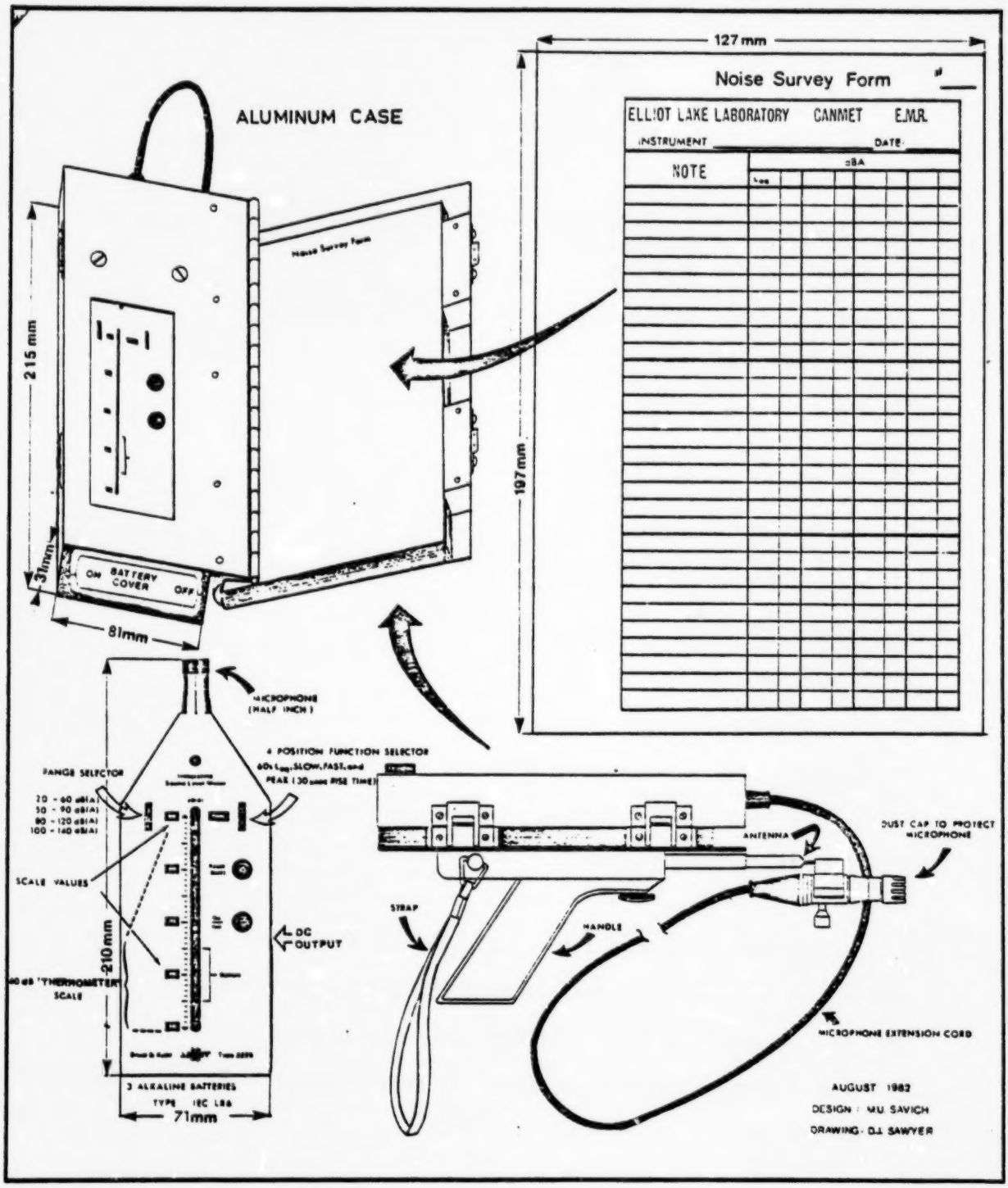

Fig. 1 - The Brüel and Kjaer Type 2225 Sound Level Meter and aluminum case.

FANS

Fans produce noise in two ways:

a) aerodynamic noise caused by air moving and being moved

b) machinery noise.

This noise is transmitted in 4 ways (2):

1) sound radiated from inlet and outlet

2) sound radiated through the fan casing

3) sound radiated through the ducts

4) sound induced by vibration transmitted to adjoining structures.

The noise can be reduced in several ways (3):

1) Choosing the fan so that it runs with optimum blade angle at peak efficiency (which is also the region of lowest noise output). Efficiency curves are available from fan manufacturers and should be consulted.

2) The use of add-on silencing devices.

3) Proper installation and maintenance.

Figure 2 shows the three sources of turbulence and the steps taken to eliminate them. This is a good example of proper installation. Silencers are effective, however, if the silencer becomes damaged (i.e., is hit and dented by large machinery) airflow is adversely affected (4). The fans must be mounted so as to present as small a target as possible.

In the category of add-on silencers are the inlet flare and the outlet cone. Both increase efficiency by reducing turbulence and must be used if the fans are to operate at peak performance (4). Induced vibration, i.e., the drumming of canvas, can only be stopped by damping the driving vibration i,e., through the use of a rigid mounting system (3).

Research has been done by the manufacturers to find the optimum operating region for each fan. More detailed information on operating

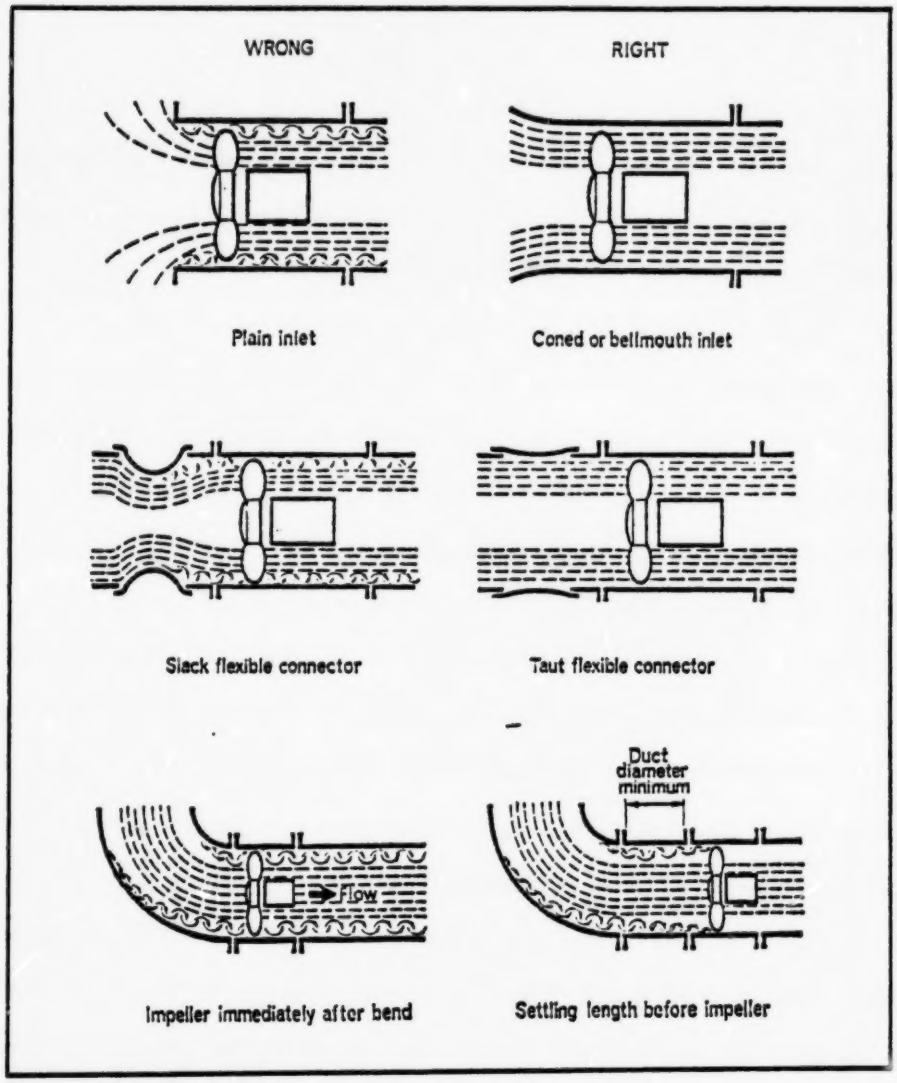

Fig. 2 - Examples of noise generating installations (Woods literature).

specifications for auxiliary mining fans and silencers is available from the fan manufacturers (Table 1).

MEASUREMENTS

The measurements taken underground at the mine were made on five different levels (Appendices A-1 to A-5). The numbers on the Appendices represent the locations of fans. These numbers are also used in Appendix B which contains the data on the fan sound levels.

Measurements were taken using the following method. The microphone was held one metre from the fan (perpendicular distance from the casing) and held facing the fan (Appendix B, see microphone position). This position is denoted as SIDE 1. The microphone was then moved to a position in front of and below the fan inlet one metre from the fan at a 45° angle from the verticle plane of the inlet. This position is denoted as SIDE 2 (Appendix B). Four measurements were taken at each position -60s L_{eq}, SLOW, FAST and PEAK.

Forty-six fans are listed in Appendix B. Only 40 of these were actually measured: 29 Davidson, 6 Woods, 4 Engart and 1 Joy. Two fans were measured twice (numbers 41 and 42). Six fans were not measured because the fan was inaccessible, idle or simply forgotten.

The data from Appendix B was then arranged in terms of manufacturer and fan diameter (Table 2). The logarithmic average of each of the four measurements were calculated. Logarithmic average was used, instead of mean and standard deviation, because it describes more realistically the effect on hearing damage risk in logarithms, as is the actual hearing mechanism.

To calculate the log. average of a group of numbers the following expression was used (5):

$$\overline{SPL} = 10 \log \left[\frac{1}{n} \sum_{i=1}^{n} \text{antilog} \frac{SPLi}{10}\right] \qquad \text{Eq 1}$$

Table 1 - Technical specifications of underground auxiliary fans at Stanleigh mine

Make	Woods	Davidson	Davidson	Woods	Davidson	Joy	Engart
Size	12"	20"	22½"	24"	36"	38"	48"
Model	12KG	Snipe fan 20-6BM	N570/15-9B	24KG	N36-75	9F3575M	48B125/LC/50
Blade setting	NA	10.5°	+5	Fixed at 16°	NA	NA	NA
R.P.M.	NA	3500	3500	3550	1875	1770	1780
Amps	NA	10	NA	32	71	61	130
B.H.P.	NA	10	20	32.0	75	50	125
Volts	NA	575	575	575	575	575	575
Hertz	NA	60	60	60	60	60	60
Phase	NA	3	3	3	3	3	3
Note						Type K	Motor type FJ (Brook Crompton)

Table 2 - Summary of noise data of auxiliary mining fans

Fan Type	# of Tests	Fan Size	Fan HP	Position	Logarithmic Average in dBA			
					L_{eq}	Slow	Fast	Peak
Woods	4	12"	0.35	Side 1	89.93	89.89	90.86	100.35
	2			Side 2	93.60	92.60	92.61	104.60
	6			Total	91.78	91.18	91.64	102.56
Davidson	8	20"	10	Side 1	104.25	103.98	104.13	114.24
	7			Side 2	103.11	103.61	103 28	116.06
	15			Total	103.79	103.83	103.78	115.13
Davidson	4	22½"	20	Side 1	105.23	102.85	103.05	114.92
	3			Side 2	99.34	98.95	98.53	110.32
	7			Total	103.57	101.57	101.64	113.49
Woods	3	24"	32	Side 1	113.34	113.00	112.84	125.84
	3			Side 2	113.17	113.00	113.27	126.50
	8*			Total	113.08	112.88	112.82	126.02
Davidson	18	36"	75	Side 1	110.58	108.80	109.32	119.75
	7			Side 2	115.24	114.37	114.79	126.74
	25			Total	112.45	111.18	111.64	123.01
Joy	2	38"	75	Side 1	103.70	103.60	103.62	114.64
	1			Side 2	102	102	102	115
	3			Total	103.21	103.13	103.15	114.76
Engart	2	48"	125	Side 1	112.03	111.81	111.81	125.03
	4			Side 2	113.50	112.50	113.50	125.50
	6			Total	112.58	112.06	112.45	125.19
Σ	70			Total	110.41			121.93

* Two measurements were taken from positions other than Side 1 or Side 2, and included in the "total" calculations.

For the program used refer to Appendix C (Table 2). The average noise level from all fans is 110.41 dBA.

From the summary of fan data in Table 2, it can be seen that the SLOW and FAST values are either the same or very close. Only the PEAK value is higher by approximately 10 to 13 dBA. From Table 2 the graph in Fig. 3 was plotted to analyze the differences between Leq and PEAK values.

The best result in terms of noise level and peak level is the Joy fan equipped with two silencers and an attenuating cover over its metal casing. The PEAK value for the Joy fan is approximately equal to the Leq value for the other fans of comparable size and power. This installation therefore is very effective. The logarithmic average of the Peak, Leq difference for all fans is 11.76 dBA. Theories concerning the production of peak noise are difficult to make because of a lack of hard data due to a lack of instruments capable of PEAK measurement. The B and K 2225 does measure PEAK values and uses a rise time of 30 μs which is very good. However, the 2225 records only the greatest peak value before the machine is reset. Certainly, we do not have data on how many peaks there have been of any given strength. A chart recorder cannot be used because they cannot move fast enough to accurately record peak values.

Acoustic impulses of extremely short duration, which may be intense enough to contribute to hearing damage, may sound relatively quiet to the observer, and therefore the possibility of a hearing hazard be overlooked (6). The pulses sound quieter because the shorter the duration of the pulse, the less sound there appears to be to an observer because of the way the ear mechanism works.

The energy of the peaks does affect the ear and hearing damage can result. An instrument is needed which will measure the number of peaks as well as their magnitude for any given time period. The rise time of such an

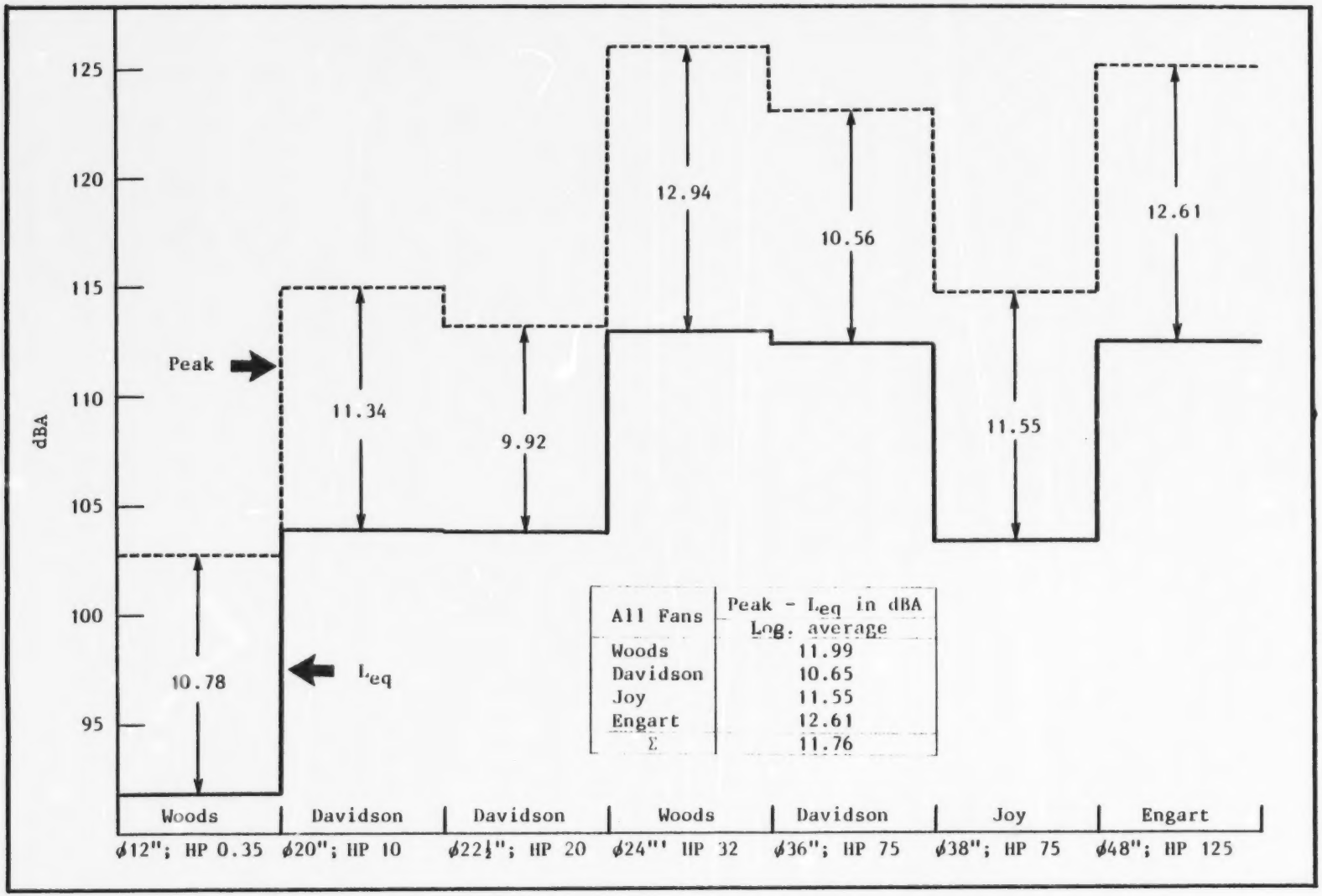

Fig. 3 - Graph of L_{eq} and PEAK values for all fans at Stanleigh mine

instrument should be as small as possible and certainly no larger than 20 ms to 640 ms (7).

CONCLUSION

The measurements taken of auxiliary mining fans at Stanleigh mine show that the difference in sound levels between fans is largely dependent on fan size and power. The average noise level of all fans is 110.41 dBA. Silencers for fans can be very effective, e.g., the case of the Joy fan. Similar techniques should be used with most or all fans in working areas of the mine.

All measurements show that maintenance in the mine (on fans) is very good. The highest peak level or the greatest difference between PEAK and 60 L_{eq} is approximately 13 dBA. The average difference is 11.76 dBA (Fig. 3). These values are close which is good.

At this time we have no theories as to what causes these peak values and this should be investigated.

Now a new element in the study of noise becomes apparent. This is the PEAK noise level measurement which should be taken into consideration in evaluating the noise exposure index (NEI) of workers.

There are little available data on peaks and the peaks should be examined in fans and all mining equipment.

ACKNOWLEDGEMENTS

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Stanleigh, and D. Restoule, the Union Environment Monitor at Stanleigh.

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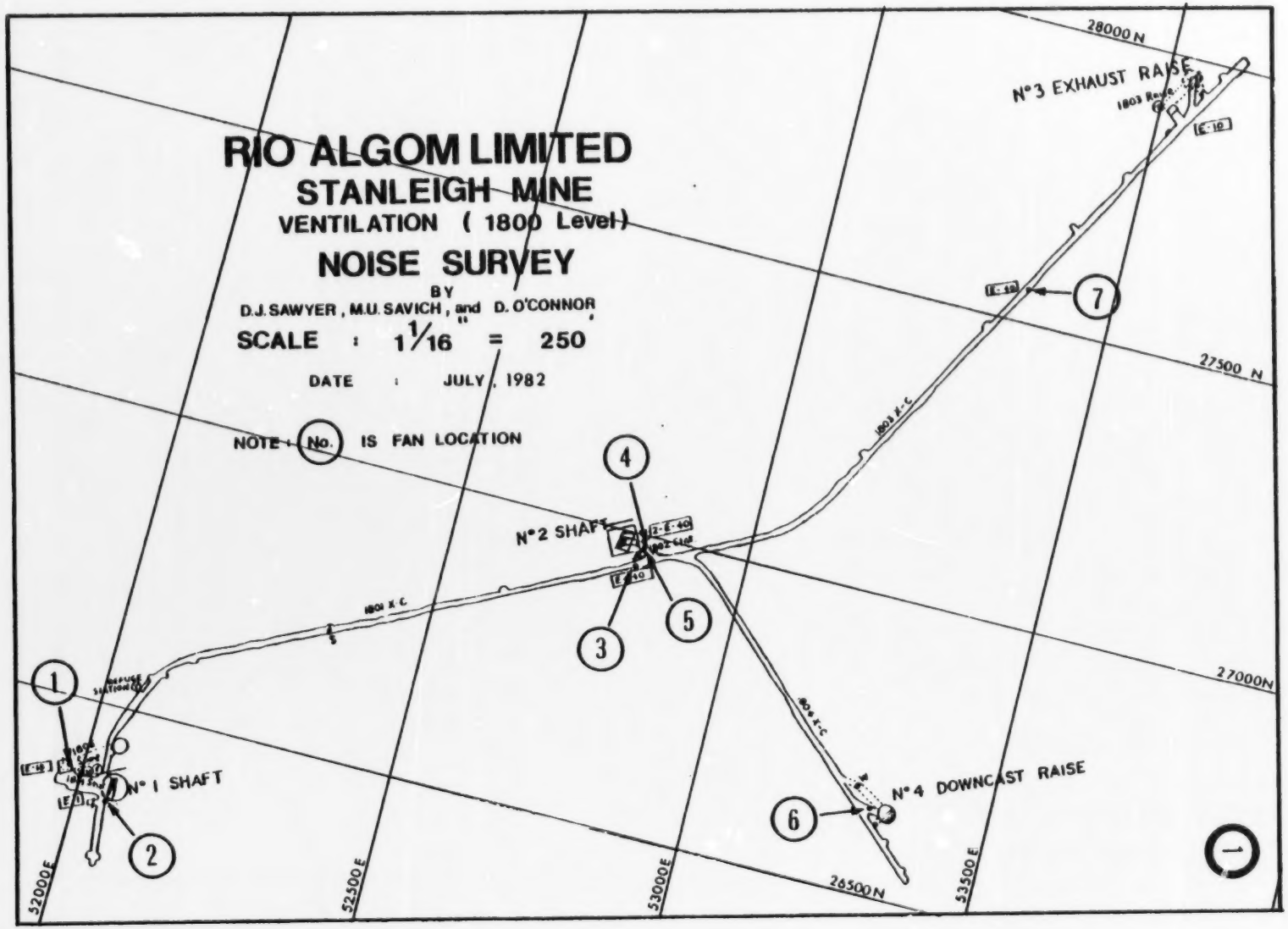
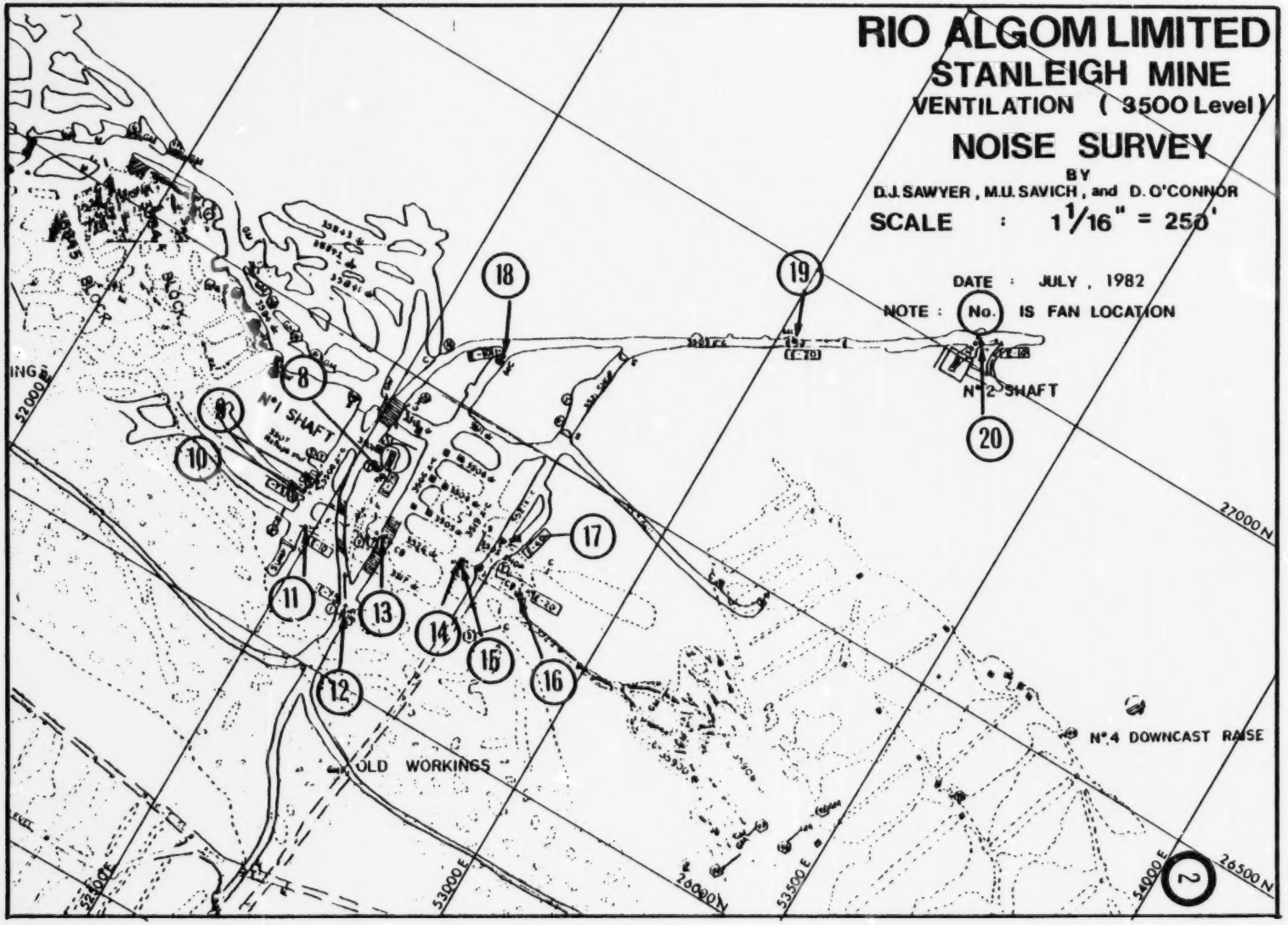

RIO ALGOM LIMITED
STANLEIGH MINE
VENTILATION (1800 Level)
NOISE SURVEY
BY
D.J. SAWYER, M.U. SAVICH, and D. O'CONNOR
SCALE : 1 1/16 = 250
DATE : JULY, 1982
NOTE : No. IS FAN LOCATION
28000 N
27500 N
27000N
26500N
52000E
52500E
53000E
53500E
N° 3 EXHAUST RAISE
N° 2 SHAFT
N° 1 SHAFT
N° 4 DOWNCAST RAISE
1800 X-C
1803 X-C
1801 X-C
1
2
3
4
5
6
7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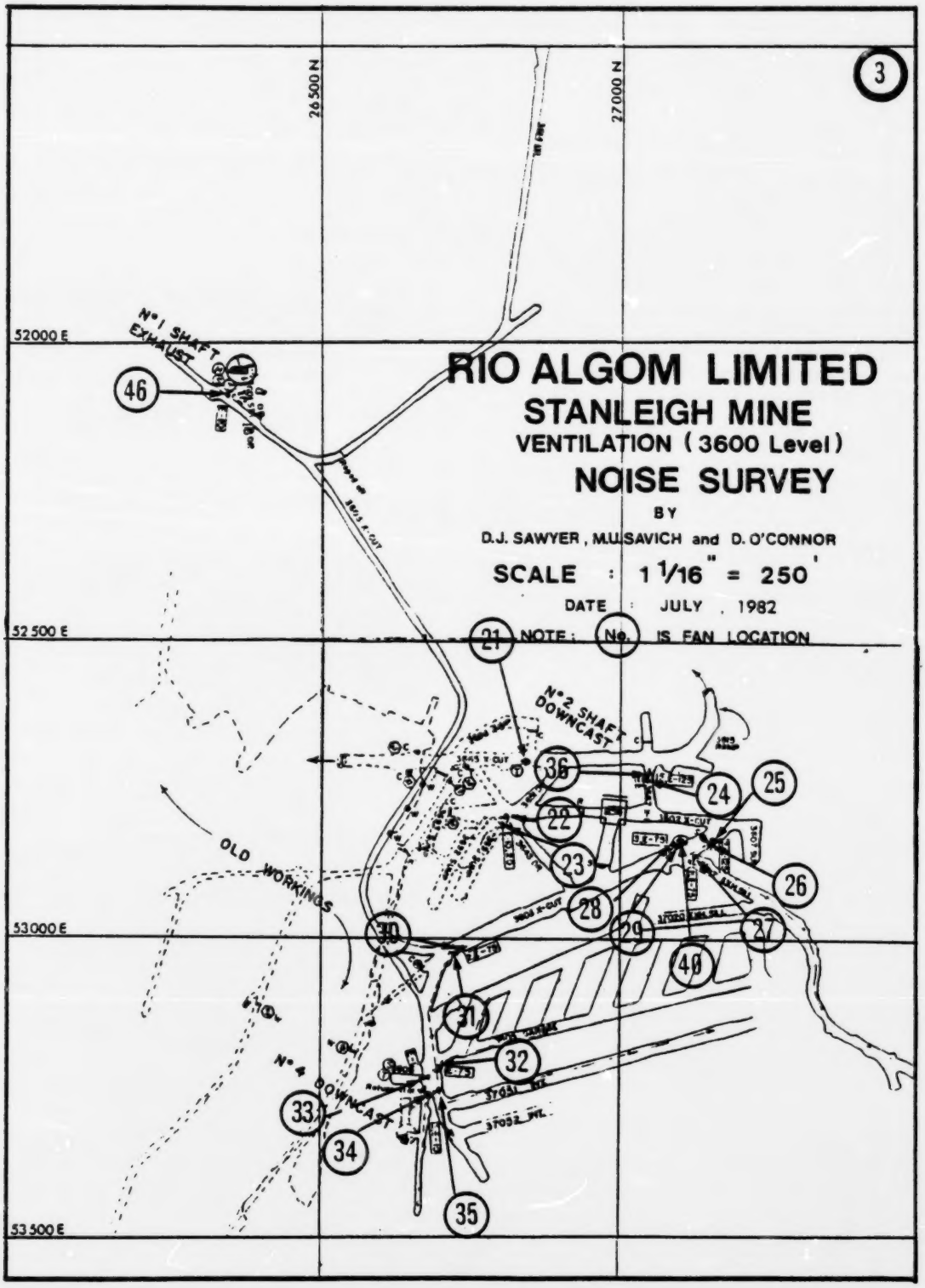
STANLEIGH MINE
VENTILATION (3500 Level)
NOISE SURVEY
BY
D.J. SAWYER , M.U. SAVICH , and D. O'CONNOR
SCALE : 1 1/16" = 250'
DATE : JULY , 1982
NOTE : (No.) IS FAN LOCATION
N°1 SHAFT
N°2 SHAFT
N°4 DOWNCAST RAISE
OLD WORKINGS
18
19
8
9
10
20
17
11
13
14
15
16
12
2
27000 N
26500 N
26000 N
32000 E
33000 E
33500 E
34000 E


RIO ALGOM LIMITED
STANLEIGH MINE
VENTILATION (3600 Level)
NOISE SURVEY
BY
D.J. SAWYER, M.U. SAVICH and D. O'CONNOR
SCALE : 1 1/16" = 250'
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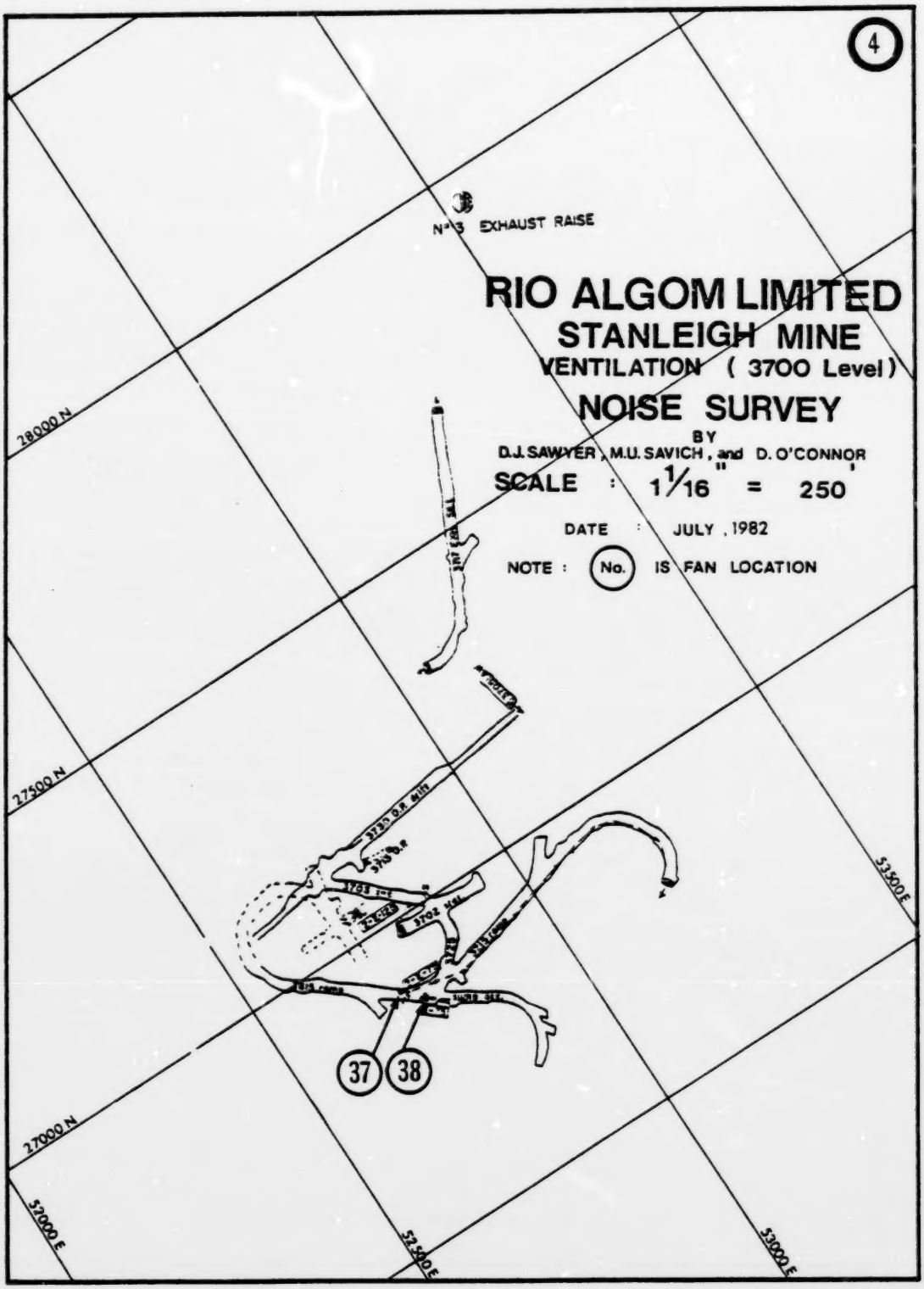
20500 N
27000 N
52000 E
52500 E
53000 E
53500 E
N°1 SHAFT EXHAUST
N°2 SHAFT DOWNCAST
N°4 DOWNCAST
OLD WORKINGS
3
46
21
36
22
24
25
23
26
28
29
27
30
40
31
32
33
34
35


4
N°3 EXHAUST RAISE
RIO ALGOM LIMITED
STANLEIGH MINE
VENTILATION (3700 Level)
NOISE SURVEY
BY
D.J. SAWYER, M.U. SAVICH, and D. O'CONNOR
SCALE : 1 1/16" = 250'
DATE : JULY, 1982
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27500 N
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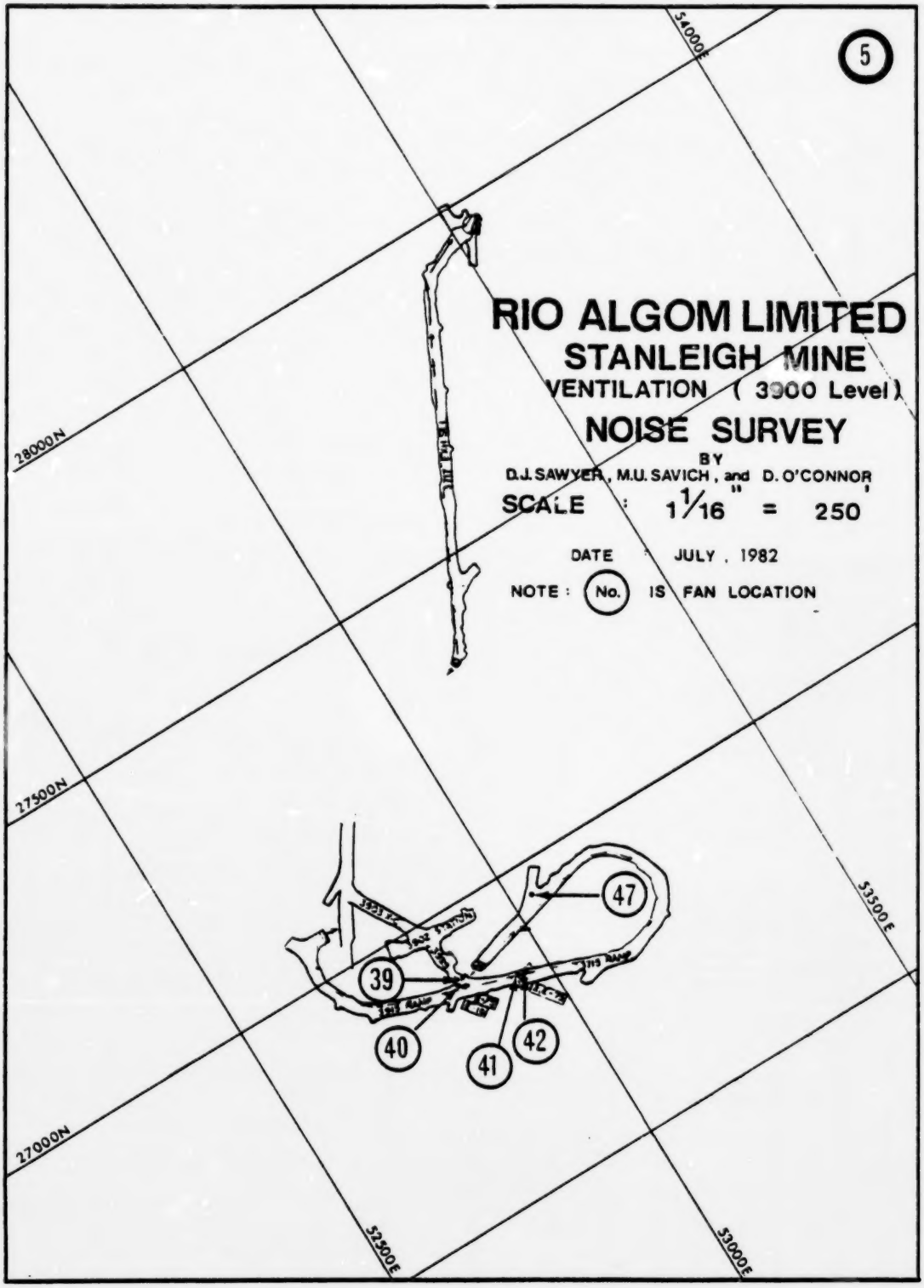
32000 E
32500 E
33000 E
33500 E
37
38


5
RIO ALGOM LIMITED
STANLEIGH MINE
VENTILATION (3900 Level)
NOISE SURVEY
BY
D.J. SAWYER, M.U. SAVICH, and D. O'CONNOR
SCALE : 1 1/16" = 250'
DATE : JULY, 1982
NOTE : (No.) IS FAN LOCATION
54000E
28000N
27500N
27000N
32500E
33000E
33500E
39
40
41
42
47

Noise measurement data of all fans

Fan No.	No. of Fan	Fan		H.P.	Microphone Position +		dBA				Note
		Type	Size		Side 1	Side 2	L_{eq}	Slow	Fast	Peak	
1	SB-7 305	Davidson	20"	10	o		95.5	95	95.5	108	1805 Sump
						o	109	110	109.5	122	
2	304	Woods	12"	0.35	o		68	67	67.5	81	1801 Station
3	SA-4 104	Woods	24"	32	o		113	113	112.5	125.5	1804 X-cut
						o	113.5	114.5	114.5	128	
4	SA-1 101	Woods	24"	32	o		113.5	113	113	126	1802 Station
		(101 was next to 105)				o	113	112	112.5	125.5	
							112.5	112.5	112	125.5	Taken next to both
5	SA-2 105	Woods	24"	32	o		113.5	113	113	126	1802 Station
						o	113	112	112.5	125.5	
		(105 was next to 101)					112.5	112.5	112	125.5	Taken next to both
6	SB-12 308	Davidson	20"	10	Not running - idle						1805 X-cut
7	SA-3 103	Woods	24"	32	Inaccessible						1803 X-cut
8	SD-13 193	Davidson	36"	75	o		104.5	105.5	105	116.5	3501 Exhaust fan
9	501	Woods	12"	0.35							3507 Refuge
10	198	Davidson	36"	75							3508 X-C Plenum Exchange
11	302	Davidson	20"	10	o		98.5	97	97	109	3508 Sump
						o	95	94	94.5	106.5	
12	199	Davidson	36"	75	o		103.5	102	102.5	114.5	
13	507	Woods	12"	0.35							3506 Electrical shop
14	116	Davidson	22"	20		o	99.5	100	99.5	111	3526 Drift
					o		94.5	93.5	96	106	
		(116 is next to 119)									
15	119	Davidson	22"	20		o	99.5	100	99.5	111	3526 Drift
					o		94.5	93.5	96	106	
		(119 is next to 116)									
16	117	Davidson	22"	20	o		92.5	92.5	93	106	3505 Garage
17	201	Davidson	36"	40							3521 X-cut
18	311	Davidson	20"	10	o		103.5	103.5	103	115.5	Fuel bay
						o	104	104	103.5	115	
19	120	Davidson	22"	20	o		111	108.5	108.5	120.5	3503 X-cut doors
						o	99	95.5	95.5	108.5	
20	201	Davidson	20"	10	o		99	99	99	109.5	3503 X-cut
						o	99.5	99	99	110.5	
21	505	Woods	12"	0.35	o						3665 Sub-station
22	SA-15 115	Davidson	22"	20	not in operation - idle						1691 Sump
23	306	Davidson	20"	10	o		92.5	93	93.5	106.5	1691 Sump
						o	100	100.5	100.5	111.5	

Fan No.	No. of Fan	Type	Size	H.P.	Position + Side 1	Position + Side 2	dBA Leq	dBA Slow	dBA Fast	dBA Peak	Note
24	230	Engart	48"	125		o	111.5	111	111	124.5	3667 X-cut
		(230 was next to 227)			o						
25	226	Engart	48"	125		o	112.5	112.5	112.5	125.5	3603 X-cut
		(226 was next to 228)			o		113.5	112.5	113.5	125.5	
26	228	Engart	48"	125		o	112.5	112.5	112.5	125.5	3603 X-cut
		(228 was next to 226)			o		113.5	112.5	113.5	125.5	
27	SD-15 182	Davidson	36"	75	o		109.5	109	110	121.5	3717 Bottom Ramp Booster
28	SD-4 197	Davidson	36"	75	o		114	114	115	126	3713 Top Waste Pass
		(197 is next to 189)				o	120	119	119.5	131.5	
29	SD-14 189	Davidson	36"	75	o		114	114	115	126	3713 Bottom Waste Pass
		(189 is next to 197)				o	120	119	119.5	131.5	
30 ★	202	Joy	38"	75	o+		93.5	90.5	91.5	103	37051 Drift
					o		106.5	106.5	106.5	117.5	
		(202 was above 206.				o	102	102	102	115	
		+ measurement was taken with Fan 200 off.									
31	200	Davidson	36"	75	o		106.5	106.5	106.5	117.5	37051 Drift
		(200 was next to 202)				o	102	102	102	115	
32	SD-17 183	Davidson	36"	75	o		98.5	108.5	108.5	110	3605 Drift
						o	98	97.5	98	110.5	
33	508	Woods	12"	0.35	o		94.5	94.5	95.5	105	3606 Refuge
						o	96.5	95.5	95.5	107.5	
34	309	Davidson	20"	10	o		99.5	99.5	100	112	3604 Raise
						o	101	100.5	101	112.5	
35	310	Davidson	20"	10	o		108.5	108.5	109	110	3616 X-cut
36	227	Engart	48"	125		o	111.5	111	111	124.5	3667 X-cut
37	SD-1 185	Davidson	36"	75	o		105.5	105	104.5	112.5	3615 Bottom Ramp Run
38	SD-11 184	Davidson	36"	75	o		105.5	105	104.5	112.5	3615 Top Ramp Run
		(184 is next to 185) booster									
47	506	Woods	12"	0.35	o		81	80	80	89	3715 Sub-station
						o	80.5	79.5	80	91.5	
39	B-13 312	Davidson	20"	10			110.5	110	110	121.5	3925 Sub-station
40	SD-12 186	Davidson	36"	75	o		115.5	114.5	115	118.5	3925 Drift
		Readings done on different days				o	101.5	98	98	111	
		(186 is below 312)									

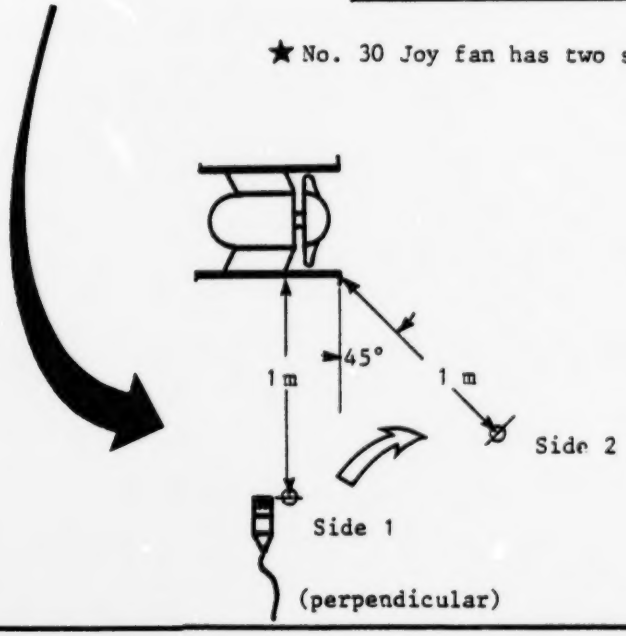
Fan No.	No. of Fan	Fan Type	Fan Size	M.P.	Microphone Position + Side 1	Microphone Position + Side 2	dBA L_{eq}	dBA Slow	dBA Fast	dBA Peak	Note
41	188	Davidson	36"	75	o		100.5	101	102.5	112	
					o		112.5	101.5	101	114	
		(188 is next to 187)									
42	SD-7 187	Davidson	36"	75	o		100.5	101	102.5	112	3715 Top Ramp Booster
					o		112.5	101.5	101	114	
*41	507 187	Davidson			o		111	110.5	110.5	123.5	3715 Top Ramp Booster
*42	507 188					o	111	111.5	111.5	123.5	Bottom Booster
43	SD-6 181	Davidson	36"	75	o		112.5	101.5	101	114	3915 Top Ramp Booster
44	SD-8 191	Davidson	36"	75	o		112.5	101.5	101	114	3915 Bottom Ramp Booster
		OORP									
		(191 is next to 181)									
45	SD-2 194	Davidson	36"	75	o		109	109	108.5	122	4102 Station
						o	112.5	112	112	123	
46	SB-8 307	Davidson	20"	10	o		97	97	97	109.5	3601 Station
						o	96	94.5	94.5	116.5	

*These measurements were taken at a later date. The first measurements were taken with ducting on intake and outlet. The second measurements were made with an open inlet.

Note: + microphone position.

SILENCER

★ No. 30 Joy fan has two silencers



Program to determine Log. average
for HP 41C:

```
PRGM
GTO ..
LBL
ALPHA LOGAV ALPHA
0.0
STO 14
0.0
STO 15
0.0
STO 16
LBL 01
ALPHA NUMBER?ALPHA
XEQ
ALPHA PROMPT ALPHA
X = 0 ?
GTO 02
10 ÷
10^x
RCL 14
+
STO 14
RCL 15
1 +
STO 15
GTO 01
LBL 02
RCL 14
RCL 15
÷
LOG
10 x
STO 16
RCL 15
R/S (Puts Stop in Program)
RCL 16
GTO .. (Puts in End)
```